

# **WARNING APPARATUS FOR SIGNALING WEAR AND TEAR OF TIMING BELT IN ENGINE**

## **CROSS-REFERENCE TO RELATED APPLICATIONS**

[001] This application claims priority of Korean Application No. 10-2003-0073408, filed on October 21, 2003, the disclosure of which is incorporated fully herein by reference.

## **FIELD OF THE INVENTION**

[002] The present invention relates to a warning apparatus for signaling wear and tear of a timing belt in a vehicle. The warning apparatus signals a user to replace the timing belt.

## **BACKGROUND OF THE INVENTION**

[003] Generally, timing belts are utilized for driving a camshaft in an internal combustion engine by interacting a rotation of a crank shaft with a rotation of a cam shaft. Such engine's may be severely damaged when timing belts are worn down by an unbalanced timing between an engine valve system and a piston system. Accordingly, it is essential that timing belts are replaced before they break and are no longer operable.

[004] However, there is a drawback in the timing belts thus described in that the timing belts are shielded by a cover, making it difficult to check with the naked eye if they are worn. As a result, undamaged timing belts generally replaced at a prescribed period without, thereby incurring avoidable expenses. Also, the timing belts may break without any indication that the timing belts have been severely worn, thereby resulting in engine damage.

## **SUMMARY OF THE INVENTION**

[005] The present invention provides a warning apparatus for signaling wear and tear of a timing belt in an engine in order for a user to timely replace the worn timing belt before it breaks. In accordance with a preferred embodiment of the present

invention, the warning apparatus for signaling wear and tear of an engine timing belt comprises magnetic force generating means or magnetic field generators each oppositely arranged about a timing belt to generate a mutually opposite polarity of magnetic force. A voltage inducing means is disposed at one lateral surface of the timing belt to induce a voltage in response to the magnetic force generated from the magnetic force generating means. A voltage detecting means or voltage detector detects the voltage induced by the voltage inducing means. A controller outputs a control signal for generating a warning signal when the voltage detected by the voltage detecting means is less than an established level. A alarm or warning generating unit generates a signal that it is time for the timing belt to be replaced in response to the control signal from the controller.

**[006]** Preferably, the voltage inducing means may comprise a pair of first conductors, each distantly disposed on one lateral surface of the timing belt in a longitudinal direction thereof, and a plurality of second conductors, each disposed on one lateral surface of the timing belt in the longitudinal direction thereof. Both ends of each second conductor is respectively connected to the pair of the first conductor.

**[007]** Preferably, the voltage detecting means may comprise a rotating body whose peripheral surface is surface-contacted with a lateral surface of the timing belt to rotate thereon, a pair of conductor belts disposed at a peripheral surface of the rotating body to respectively surface-contact the pair of first conductors, a connecting unit electrically connected to the pair of conductor belts, and a voltage meter detecting a voltage between the pair of conductor belts via a connecting unit.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[008] For a better understanding of the nature and objects of the present invention, reference should be made to the following detailed description with the accompanying drawings, in which:

[009] FIG. 1 is a schematic block diagram for illustrating a warning apparatus for signaling wear and tear of a timing belt in an engine according to an embodiment of the present invention;

[0010] FIG. 2 is an enlarged drawing of essential parts of a timing belt of FIG. 1;

[0011] FIG. 3 is a side view of an idler of FIG. 1; and

[0012] FIG. 4 is a schematic drawing depicting an operational principle of the present invention.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[0013] The preferred embodiment of the present invention will now be described in detail with reference to the annexed drawings. The present embodiment should not limit the scope of the present invention, and is described for illustrative purposes only.

[0014] As shown in FIGS. 1, 2 and 3, a warning apparatus for signaling wear and tear of a timing belt in an engine includes a timing belt 1, magnetic force generating means 10, a pair of first conductors 20, a plurality of second conductors 21, a rotating body 30, a pair of conductor belts 40, a pair of connecting units 50 and 51, a voltage meter 60, a controller 70, and an alarm generating unit 80.

[0015] The timing belt 1 is mounted at a timing belt system of an engine for coupling rotation of a cam shaft with rotation of a crank shaft. The magnetic force generating means 10 includes a pair of permanent magnets arranged about the timing

belt 1, each having an opposite polarity, to allow a magnetic force to pass through the timing belt 1.

**[0016]** The pair of first conductors 20 are respectively arranged on a lateral surface of the timing belt 1 in the longitudinal direction of the timing belt. The pair of first conductors 20 is preferably disposed opposite to one another. Furthermore, the pair of the first conductors 20 are preferably disposed at an area adjacent to both edges of the timing belt 1, such that an abraded condition just before breakage of the timing belt 1 can be immediately detected.

**[0017]** The plurality of second conductors 21 are respectively arranged on a lateral surface of the timing belt 1 in the longitudinal direction thereof. Each end of the second conductors is connected to the pair of the first conductors 20.

**[0018]** The peripheral surface of the rotating body 30 tightly contacts the first conductors 20 and the second conductors 21 mounted on the lateral surface of the timing belt 1. By way of example, the rotating body 30 may be an idler mounted on a timing belt system of an engine for forming a contact angle with the timing belt 1 or providing appropriate tension. The pair of conductor belts 40 are respectively mounted on a peripheral surface of the rotating body 30 to contact the surface of the pair of first conductors equipped at the timing belt 1 and to conduct electricity.

**[0019]** The pair of connecting units 50 and 51 are respectively connected to a pair of conductor belts 40 equipped at a peripheral surface of the rotating body 30. The pair of connecting units 50 and 51 apply voltage applied to the pair of conductor belts 40 to the voltage meter 60.

**[0020]** By way of example, as shown in FIGS. 1 and 2, the connecting units 50 and 51 may be any type of devices, as long as they connect electrically to a rotating

object. For example, they may be brush type conductors, rollers rotating in cooperation with the rotating body 40, or the like.

**[0021]** The voltage meter 60 detects the voltage between the pair of conductor belts 40 equipped at the rotating body 30, via the connecting units 50 and 51, to output a detected signal corresponding thereto. The controller 70 receives the detected signal outputted from the voltage meter 60 detecting the voltage between the pair of conductor belts 40 mounted at the rotating body 30, and outputs a control signal for generating a warning signal if the detected voltage is less than an established level.

**[0022]** The alarm generating unit 80 generates a warning signal for notifying a user that the timing belt should be replaced, in response to the control signal outputted from the controller 70. The unit 80 may be, for example, a buzzer for outputting a warning sound, a warning lamp, or an indicating element for indicating a warning comment.

**[0023]** An operational example of the present invention will now be described in detail with reference to the accompanying drawings.

**[0024]** Referring to FIG. 4, when an engine starts to move the timing belt 1, the timing belt 1 passes through the magnetic force generated between the permanent magnets 11 and 12 of the magnetic force generating means 10 to cause induced electromotive force to be generated in the plurality of second conductors 21 at the timing belt 1 in response to Fleming's right-hand law. This induces a current, such that the voltage difference between the pair of the first conductors 20 becomes identical with that between both ends of the plurality of second conductors 21. For instance, when a conductor disposed in a magnetic field is moved by an external force, an induced current flows in the conductor, where Fleming's right-hand law is defined by a

conductor's moving speed, a direction of the magnetic field and a direction of the current. The Fleming's right-hand law is the principle of a generator.

**[0025]** According to Fleming's right-hand law, an induced electromotive force (E) is defined by a vector product of motion (F) and magnetic flux (B), where the induced electromotive force induced on the second conductor 21 grows larger in proportion to the speed of the timing belt 1.

**[0026]** The voltage between the pair of first conductors 20 equipped at the timing belt 1 is detected by the voltage meter 60 via the pair of conductor belts 40 and the pair of connecting units 50 and 51, from which a detected signal corresponding to a voltage level detected by the voltage meter 60 is outputted. The controller 70 detects the voltage between the pair of the first conductors 20 disposed at the timing belt 1 in response to the detected signal outputted from the voltage meter 60. The controller 70 then compares the detected voltage with the established level, and determines that the timing belt 1 is fine if the detected voltage is above the established level.

**[0027]** Abrasion of the timing belt 1 starts from both edges thereof, and if the timing belt 1 is so abraded as to break, the pair of the first conductors 20 arranged near both edges of the timing belt 1 will break and/or cut off. When the first conductors 20 of the timing belt 1 break, a circuit to the voltage meter 60 is opened via the second conductors 21, the first conductors 20, the conductor belt 40 and the connecting units 50 and 51 such that the induced electromotive force induced on the second conductors 21 is not detected and a voltage of less than the established level is detected by the voltage meter 60.

**[0028]** If the voltage detected by the voltage meter 60 is less than the established level, the controller 70 determines that the timing belt 1 is worn, broken, and/or has snapped and outputs a control signal for generating a warning signal. When a warning

signal is generated from the alarm generating unit 80 notifying that it is time to replace the timing belt in response to the control signal from the controller 70, a driver or a maintenance person can easily perceive that it is time to replace the timing belt.

**[0029]** The foregoing description of the preferred embodiment of the present invention has been presented for the purpose of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents.

**[0030]** As apparent from the foregoing, there is an advantage in the warning apparatus for signaling wear and tear of a timing belt in an engine thus described according to the embodiment of the present invention in that, when a timing belt is worn to the point that it is badly damaged, a warning signal is given by a detection thereof such that a n undamaged timing belt does not need to be changed periodically. This reduces the expenses for replacing undamaged timing belts and severe damage to an engine, caused by a worn timing belt not being timely replaced, can be prevented.